

---

# 2008 Solar Annual Review Meeting

**Session: CSP Trough Systems**

**Company or Organization: Abengoa Solar**

**Funding Opportunity: CSP Trough Systems Solicitation**



Hank Price  
Abengoa Solar Inc.  
Lakewood, CO 80215

**ABENGOA SOLAR**

# Overview



- Relationship to Solar Program Goals
  - “...to make **CSP** cost competitive in the intermediate power markets by 2015 (~7¢/kWh with 6 hours of storage) and in baseload power markets (~5¢/kWh with 16 hours of storage) by 2020.”
- Project description
- Major Activities
- FY08 Progress
- FY09 Planned Activities
- FY10 and Beyond

- Parabolic Trough Collector Development
- Reflective Film Development
- Molten-Salt Heat Transfer Fluid for Parabolic Trough Plant

### Parabolic Trough Collectors

#### Technologies Addressed

Trough Component Manufacturing -  
parabolic trough concentrators

#### Description

Development of innovative and improved  
parabolic trough concentrator designs that  
can have a major impact on this cost  
element.

#### DOE Goals Served

LCOE / U.S. based manufacturing

#### LCOE Impact

Potential to meet DOE  
2015 cost target



#### Resources (\$)

Total Project	DOE Funds	Cost Share
\$624K	\$499K	\$125K

## Goals

- The goal of this project is to reduce the cost of near term parabolic trough collector technologies.
- This project will analyze the concentrator structure, the reflector that integrates into that structure, foundations and installation techniques - components that comprise over 60% of the installed cost of a parabolic trough solar field.
- We will conduct a detailed evaluation of several concentrator designs, broken into three phases. Each phase has a progressively increasing scale, starting with single modules, then progressing to half-loops and on to multiple loops.

### Tasks

#### Phase I Collector Analysis

2008

- Metrics
- Models (optical & structural)
- Design & Cost Analysis
- Prototypes
- Optical & Structural Testing

#### Phase II Prototype Collector Field Tests 2009

- Full-scale wind load testing
- Field Deployments
- Installation Methods
- Advanced Concentrator Design
- Economic Analysis

#### Phase III Collector Loop Tests

2010

### Advanced Polymeric Reflectors

#### Technologies Addressed

Trough component manufacturing - mirrors

#### Description

An advanced solar reflective material will be transitioned from laboratory scale to limited production runs at commercial scale.

#### DOE Goals Served

LCOE / U.S. based manufacturing

#### LCOE Impact

\$.005/KWh



#### Resources (\$)

Total Project	DOE Funds	Cost Share
\$560K	\$448K	\$112K

### Goals

- The reflective film project will develop and scale-up a previously demonstrated advanced solar reflector material (ASRM) for use in CSP applications. This technology is promising both for its potential lower cost, and potential new low-cost concentrator designs based on its flexibility and durability.
- An existing ASRM, last produced in 2003 under sponsorship by NREL, will be transitioned from a laboratory-scale to limited production runs on a commercial scale 48-inch wide roll coater. This objective is broken into smaller objectives to be pursued in three phases corresponding to budget periods:



### Tasks

Phase I	Transfer, model, and validate roll to roll ASRM processes	2008
	<ul style="list-style-type: none"><li>• Transfer Technology</li><li>• Duplicate previous quality</li><li>• Add End Hall Ion source</li><li>• Modify Process/Cost Model</li></ul>	
Phase II	Scale-up to pilot production	2009
	<ul style="list-style-type: none"><li>• Build Pilot Production Chamber</li><li>• Produce and Test Pilot Production Samples</li><li>• Collector Test Samples</li><li>• Update Cost Model</li></ul>	
Phase III	Additional scale-up and field testing/validation	2010
	<ul style="list-style-type: none"><li>• Upgrade deposition to full width</li><li>• Produce and Test Limited Production Samples</li><li>• Collector Test Samples</li><li>• Test performance/durability through NREL</li><li>• Update Cost Model</li></ul>	

## Molten Salt Heat Transfer Fluid

### Technologies Addressed

Advanced low cost thermal storage for CSP power plants

### Description

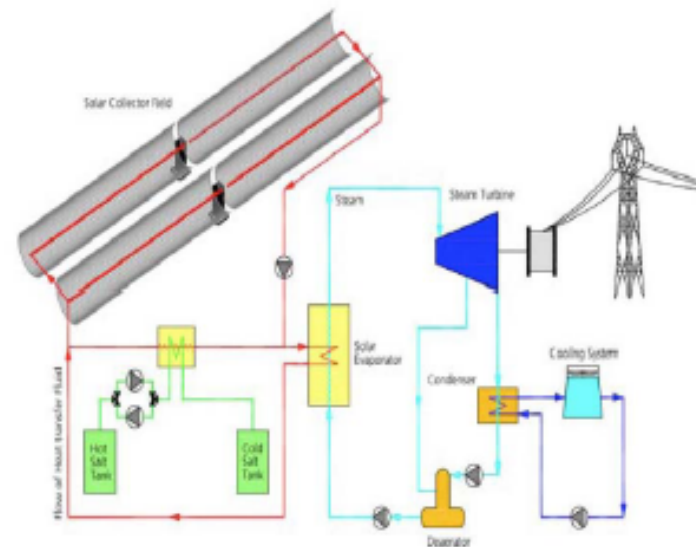
Combine the use of a molten salt heat transfer fluid with molten salt thermal energy storage to reduce costs and increase the dispatchability of CSP plants.

### DOE Goals Served

LCOE / Thermal energy storage

### LCOE Impact

10-15% with storage



### Resources (\$)

Total Project	DOE Funds	Cost Share
<b>\$625k</b>	<b>\$500k</b>	<b>\$125k</b>

## Goals

- The goal of this effort will be to develop the technologies required to allow the low freeze point molten-salts to be used in a parabolic trough solar field and to provide the opportunity to conduct the field testing necessary to allow this technology to be introduced into commercial solar plants at the end of this effort.
- Phase 1 activities focus on the initial research and development necessary to prove the feasibility of molten salt HTF in the solar field.
- Phase II includes development of prototypes and small scale testing of the technologies developed in phase I.
- Phase III is full-scale and/or field testing of various components.

### Goals

#### Phase I Concept Feasibility

2008

- Molten-salt Design Basis
- Develop molten-salt collector technology (collector, interconnect, receiver, freeze protection)
- Molten-Salt Plant Design (SF, TES, SGS, BOS)
- Engineering Assessment

#### Phase II Prototype Development

2009-2010

- Test Collector Interconnection
- Test Freeze Protections
- Prototype Collector
- Laboratory Thermocline TES Test
- Test Loop Design

#### Phase III Field Demonstration

2010-2011

- Molten-Salt Collector Loop
- Expanded Molten-salt Collector Field
- Thermocline Test
- Operational Testing
- Final Assessment

## Status

- Negotiating contract with DOE
- Detailed project planning
- Staffing
- Precontract work:
  - Developing optical and structural modeling and testing capabilities
  - Abengoa Solar (Spain) working on Solucar TR design
  - Work progressing on IST designs (NREL R&D contract)
  - Developing aluminum design

### EuroTrough II



### Solucar TR



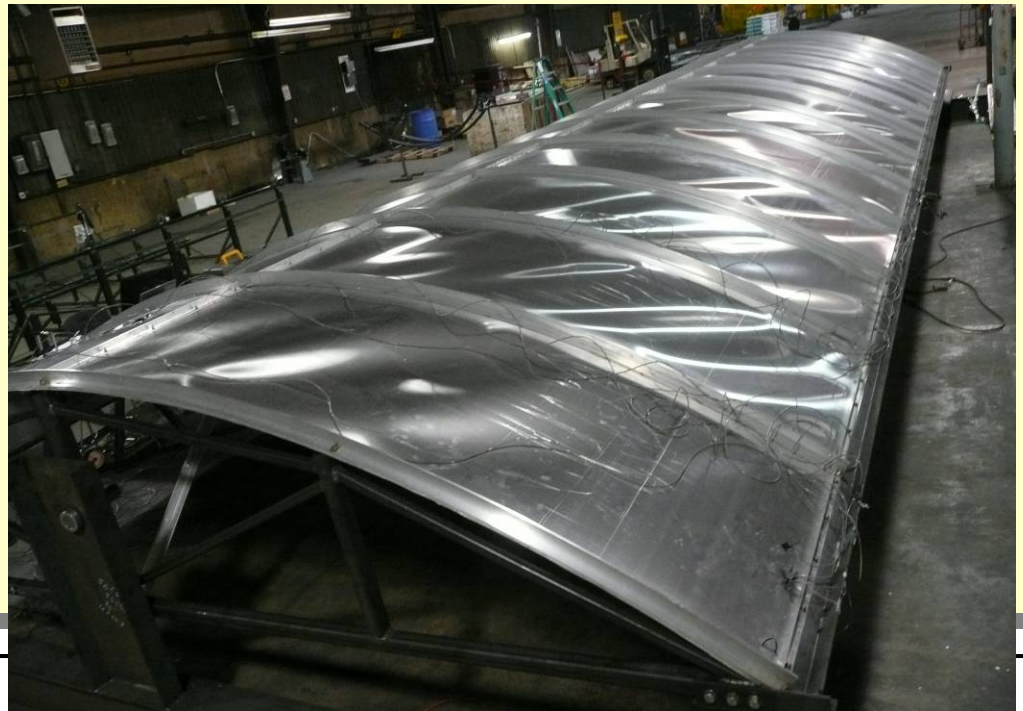
### IST PT-2



Others:

- IST Focal Point Power Trough
- Aluminum
- Others





## Phase II

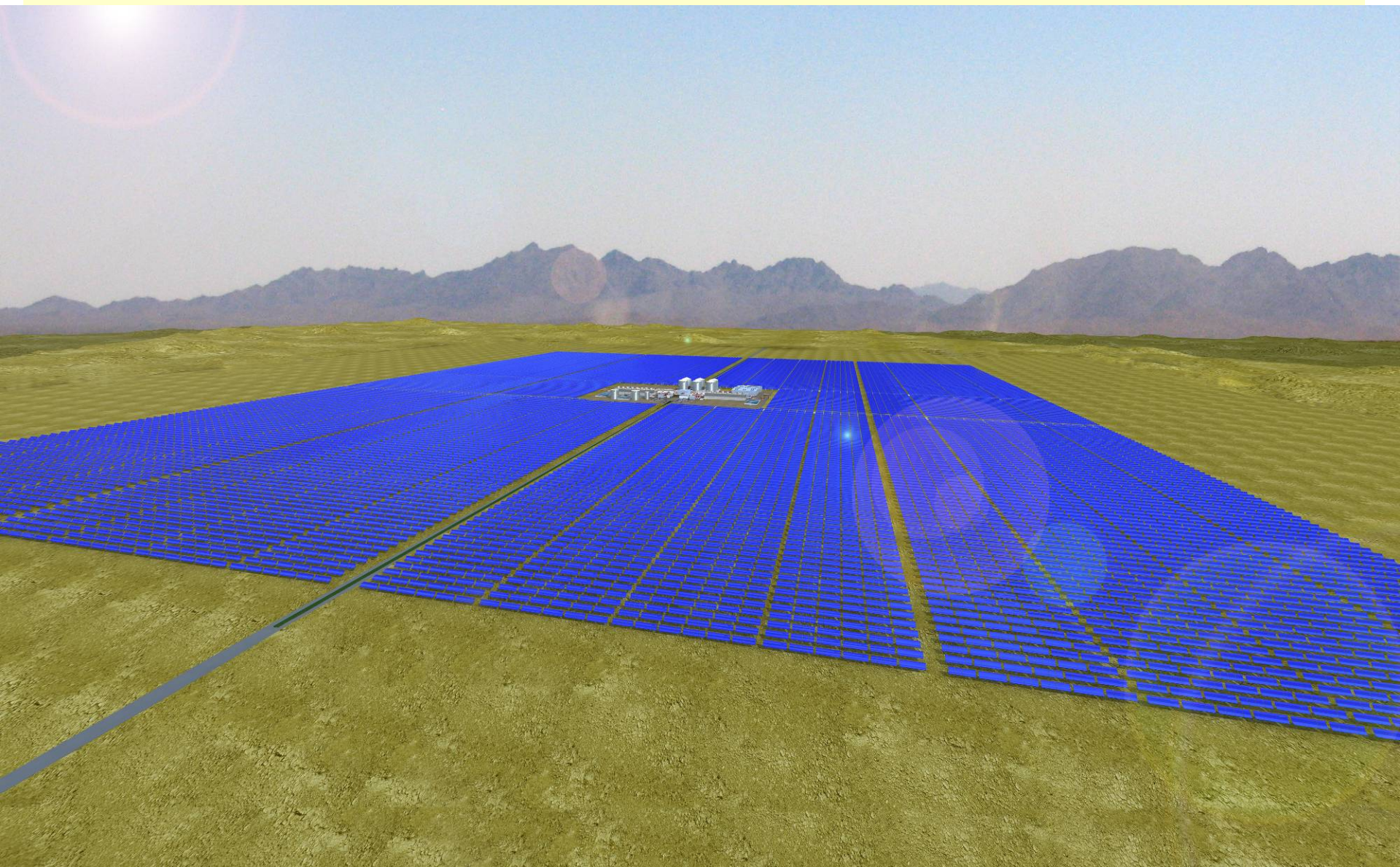
- Collector Development
  - Full-scale wind testing
  - Prototyping of near-term & advanced collector designs
  - Loop testing of near-term collector designs
- Reflective Film
  - Scale-up of reflective film roll coater
- Molten-Salt
  - Testing of molten-salt components
  - Prototype molten-salt collector
  - Lab scale test of thermocline TES
- Budgets (TBD)



### Phase III Activities

- Collector Development
  - Loop testing of near-term and advanced collectors
- Reflective Film
  - Scale-up to production roll to roll coater
- Molten-salt HTF
  - Field test of collector loop (s)
  - Molten-salt thermocline TES system test

- Collector
  - VSHOT Testing
  - Optical modeling support
  - Optical efficiency test
  - Full-scale wind testing
- Reflective Film
  - Optical materials technical support and characterization
- Molten-Salt
  - Low-temperature molten-salt
  - Testing TBD in Phase I
- Other
  - TOP Testing



- Plant Size: 280 MW gross generation,  
2 x140 MW turbines  
(~250 MW net after station  
parasitic loads)
- Thermal Energy Storage: 6 hours of generation
- Collector Type: Parabolic Trough
- Collector Area: 2,200,000 m<sup>2</sup>
- Land Area: 3 square miles
- Annual Generation: 900,000,000 kWh  
41% annual capacity factor
- On-Peak Generation: 95% capacity factor  
hours noon – 8 pm  
June – September
- Expected On-Line Date: 2011





- 1** Parabolic mirrors heat a petroleum-based fluid.
- 2** Hot fluid returns from the solar field.
- 3** The hot fluid transfers its heat energy to water, creating steam.
- 4** Steam drives a turbine, producing electricity.
- 5** The hot fluid will also heat molten salt.
- 6** If the sun is not shining, the fluid can be heated by the molten salt.
- 7** Fluid sent back to the solar fields.

- “Solana” Spanish for “sunny place.”
- Plant located on agricultural land 70 miles southwest of Phoenix, near Gila Bend, Ariz.
- Will generate enough electricity to serve 70,000 APS customers
- Over \$1 billion in total investment
- 1,500 construction jobs over 2 years
- 85 full time jobs to operate and maintain the plant
- Will use 1/4 the amount of water of current crop usage.
- Will generate 50x as much revenue per acre as crops
- APS Considers Project Economically Attractive but requires the 30% ITC extension.

